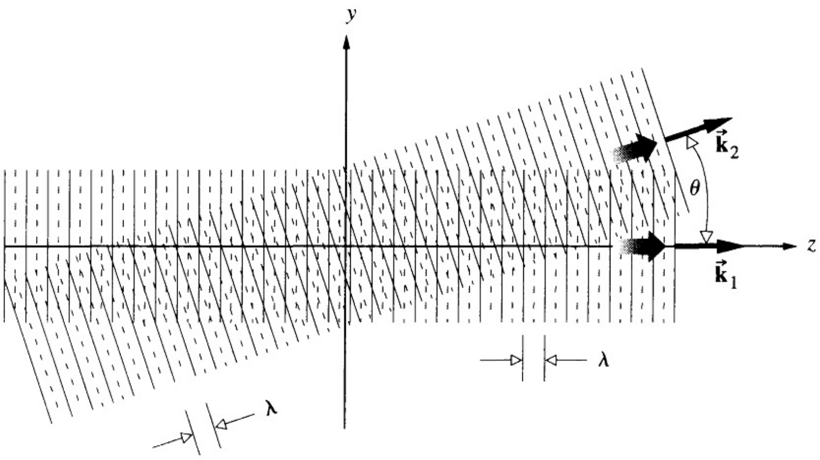
Problem 1

Consider figure below and prove that if two electromagnetic plane waves making an angle θ have the same amplitude, E_θ, the resulting interference pattern on the yx-plane is a cosine-squared irradiance distribution given by



$$I(y) = 4E_0^2 \cos^2\left(\frac{\pi}{\lambda} y \sin\theta\right)$$

Locate the zeros of irradiance. What is the value of the fringe separation? What happens to the separation as θ increases? Compare your analysis with that leading to the following equation.

$$I = 2I_0(1 + \cos\delta) = 4I_0 \cos^2\frac{\delta}{2}$$

Problem 2

An expanded beam of red light from a He-Ne laser ($\lambda = 632.8\ nm$) is incident on a Screen containing two very narrow horizontal slits separated by 0.200 mm. A fringe pattern appears on a white screen held 1.00 m away.
(a) How far (in radians and millimeters) above and below the central axis are the first zeros of irradiance?
(b) How far (in mm) from the axis is the fifth bright band?
(c) Compare these two results.

Problem 3

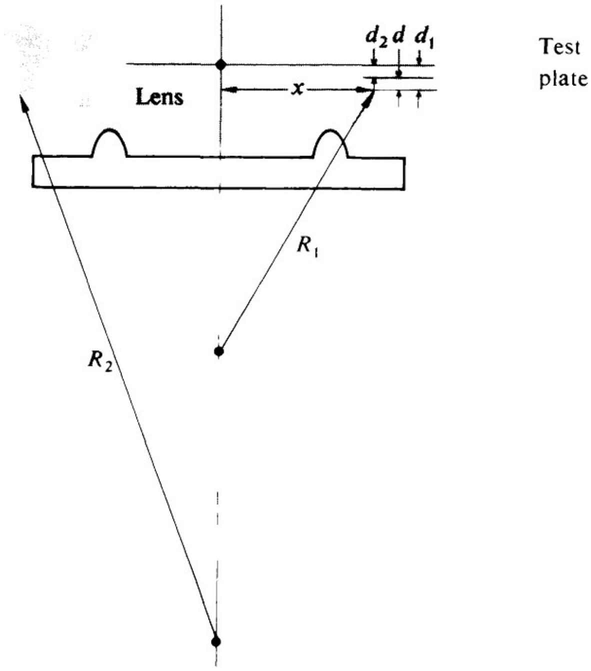
Plane waves of monochromatic light impinge at an angle θ_l on a screen containing two narrow slits separated by a distance a. Derive an equation for the angle measured from the central axis which locates the mth maximum.

Problem 4

A soap film surrounded by air has an index of refraction of 1.34. If a region of the film appears bright red ($\lambda_0 = 633\ nm$) in normally reflected light, what is its minimum thickness there?

Problem 5

Figure below illustrates a setup used for testing lenses. Show that



$$d = x^2(R_2 - R_1)/2R_1R_2$$

when d_1 and d_2 are negligible in comparison with $2R_1$ and $2R_2$, respectively. (Recall the theorem from plane geometry that relates the products of the segments of intersecting chords.) Prove that the radius of the mth dark fringe is then

$$x_m = [R_1R_2m\lambda_f/(R_2 - R_1)]^{1/2}$$

How does this relate to the following equation?

$$x_m = (m\lambda_f R)^{1/2}$$

Reference

E. Echt, Optics, Fifth edition (Oldenburg, München, 2009).